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ABSTRACT

Previous research by Maratsos found that 3-year-olds were more accurate than four and 5-year-olds in selecting 'big' rectangles or animals when choosing between pairs of stimuli. A study then investigated the nature of the previous experiments themselves, particularly the procedures the researcher followed and the possible inferences which he drew from these. Subjects, 109 children, were selected from three playgroups and two primary schools in a predominantly middle class area outside Reading, England. Included in the study were 20 boys and 20 girls aged 5, a similarly composed group of children who were nearly 8 years of age, and 12 boys and 17 girls under 3.5 years of age. (Fifty-three psychology undergraduate students were also tested.) Using Ravn and Gelman's method, 14 stimulus pairs were used. They consisted of rectangles cut from heavy white card, the area ratios between them always being 1.8:1 or greater, with a variety of height and width contrasts. Each subject was seen individually and tested in a quiet area apart from the classroom. Results indicated a significant difference between groups and no difference in "no rule" usage across the three age groups, significantly more correct rule usage at the ages of 3 and 8, and more height rule usage at the ages of 5 and 8 than at age 3. (Seven data tables and a figure are included.) (JK)

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Changes in Rule Usage in Children's Understanding of 'BIG'

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Research into children's understanding of polar adjectives, like 'big' and 'little', has interested developmentalists over the past twenty years . Such adjectives are said to constitute a well defined set of semantically related words which enable us to test theories concerning the acquisition of word meaning. Like others before and since (e.g. Lumsden and Poteat,1967), Maratsos (1973,1974,) found that three year olds were more accurate than four and five year olds in selecting 'big' rectangles or animals when choosing between pairs of stimuli. He suggested several possible causes for these findings, but settled for a cognitive explanation - that the four or five year old child becomes perceptually hooked upon the top-point or vertical dimension of the objects she categorises and her use of language to denote differences between stimuli suffers as a result.

Two types of investigation have examined the results obtained by Maratsos in a critical light. Firstly, some cross-linguistic research has suggested a semantic basis for the decrements in English speaking children's performance, since Arabic speaking five year olds appear to have no difficulty in performing the tasks designed by Maratsos (Gathercole, 1982). (In Arabic one word [tawiil] refers to extension on the vertical or horizontal dimensions, so children do not confuse the term big [kabiir] with extensions along one plane). While such findings have contributed to the wider debate concerning the relative importance of semantic and cognitive factors in language development. both explanations share the assumption that the confusion shown by the five-year-old is paradoxically an indicator of her increased linguistic sophistication.

The second area of study, which is the main focus of today's paper, concerns the nature of the Maratsos experiments themselves, particularly the procedures he followed and the possible inferences

which he draws from these. In one examination of children's understanding of big, Maratsos provided three to five year olds with two types of stimuli to compare. The first were rectangles of similar height but different width, the second were of slightly different heights but the width differences between them were much greater. He had assumed that judgements of size were made either by area or by considering height alone. However, criticisms of this assumption (Bausano and Jeffrey, 1975; Ravn and Gelman, 1984) point out that in solving problems like these, children might consistently use a number of rules other than those based on area or height: according to the width of the stimuli presented, the salient dimension of one of the two items (i.e. the stimulus which contains the dimension of greatest extent) and the salient-dimensional difference rule (the stimulus in which one dimension shows the greatest difference between the two stimuli).

In 1984 Ravn and Gelman published findings which suggested that the age decrement apparent in previous studies might have arisen because experiments failed to allow for the possibility that children might use such a variety of rules when making size comparisons. They presented subjects with 14 stimulus pairs, with greater height and width contrasts than had previously been used, in order to determine children's rule usage. Unlike Maratsos they found no decrement in performance between three and five years and that three year olds were less likely to use a rule of any sort than five year olds. If Ravn and Gelman's data are reliable , there is no U-shaped development of children's understanding of terms like big and theoretical speculation about the causes of the result obtained by Maratos would be superfluous.

However we cannot simply accept Ravn and Gelman's results. They

examined only a few subjects at each age and our pilot work involving over 150 participants suggested that younger children do appear to be consistent in their judgements over many trials. This paper reports the findings of a replication of the Ravn and Gelman study using a much larger sample of three and five year olds. It's main aim is to examine whether assessing children's use of the term 'big' with Ravn and Gelman's comprehensive test reveals a decrement in understanding, as Maratsos would predict. In addition the study examined three further issues. Firstly, in previous experiments including that by Ravn and Gelman, children were pre-tested with rectangle pairs where one was both taller and wider than the other. In order to examine whether such a trial might encourage what Ravn and Gelman term Height Rule usage (a fixation upon the top point of each stimulus) we started half the subjects on the first experimental trial which was an equal height, different width comparison. No effect was found, so we will not discuss this variation in procedure here. Secondly, we tested a group of eight-year-olds to examine the validity of an assumption made in the literature that the decrement shown at five years is made up, shortly thereafter. Thirdly, we felt uneasy about measuring change using only a cross-sectional design. We examined the three-, five and eight-year-olds on two occasions eight months apart in order to gain some insights into the stability of individuals' rule use over time and to discover any regularities in rule change.

Table 1 here

We tested 109 children from 3 playgroups and two primary schools in a predominantly middle class senior school catchment area, outside Reading. There were 20 boys and 20 girls aged five and nearly eight

and 12 boys and 17 girls under three-and-a-half. (53 pychology undergraduate students were also tested). Using Ravn and Gelman's method, 14 stimulus pairs were used. They consisted of rectangles cut from heavy white card, the area ratios between them always being 1.8:1 or greater. All subjects were presented with the trials in the following order.

Figure 1 here

Four of the rectangle pairs, the equal height pairs (B and C) and two of the unequal height pairs (F and G) were used in the original Maratsos study. The extreme dimension rectangles (pairs I,J,K and L) were added by Ravn and Gelman to provide a clear test of the rules they use. Each rule generates a pattern of predicted responses and children can be scored for each rule accordingly.

Table 2 here

For example, a Height Rule user would consistently respond " the same" to equal height rectangles and on trials with unequal height rectangles would base their judgements on height alone. Following a procedure devised by Siegler, Ravn and Gelman attributed rule usage to a child if she answered 8 out of 9 trials appropriately according to that rule.

Each child was seen individually and tested in a quiet area apart from the classroom. The subject was seated opposite the experimenter at a

low table. She was asked her name and then the experimenter proceeded to show her the pairs of rectangles. As the first rectangles were presented the experimenter said, " I have some shapes for you to look at; now, can you tell me which one is the big one?". As each rectangle pair was presented the experimenter asked,"Which one is the big one?". In all cases the experimenter replied "good" and the stimuli were removed from the table.

Following Maratsos and Ravn and Gelman, each stimulus pair was presented standing up rather than flat on the table. The position of the rectangles in each pair (right, left, top, bottom,) was counter-balanced.

We analysed our data in several ways and will discuss now the two most resembling Ravn and Gelman's. Firstly we examined correct responses to 9 of the 14 pairs of stimuli at each of the different age groups. In their analysis Ravn and Gelman omitted the equal width comparisons, presented one above the other, and the same size comparisons. We follow their guidelines in this analysis although inclusion of the equal width comparisons makes no difference to the results.

Table 3 here

This table presents the mean numbers of correct trials out of 9 for each of the 3 age groups. A one way ANOVA was carried out to compare the relative performance of the three-, five an eight-year-olds. It shows a significant difference between groups. A Tukey test reveals a significant difference between the 3 and 5 year olds, although

examination of the standard errors suggests that the 3 year olds also had higher scores than the 8 year olds.

Table 4 here

Our second analysis considers children's use of rules according to Ravn and Gelman's rule assessment procedure. This method allowed us to classify 62% of 3 year olds, 62.5% of 5 year olds and 72.5% of 8 year olds as using a rule for 'big'. (Comparative scores for Ravn and Gelman's study are 50% for 3 year olds and 90% for 5 year olds). The remaining children were classified as No Rule users. Ravn and Gelman found no 3 year olds using a correct rule. In contrast we found 12, or 41%, of our 3 year olds were using this rule and most of these made all the judgements correctly. Amongst the two older groups there was an increased frequency in height rule usage and a few children at each age used one of the two salient dimension rules consistently across trials. Chi-square analyses revealed no difference in "No Rule" usage across the three age groups, significantly more Correct Rule usage at 3 and 8 and more height rule usage at 5 and 8 than at three.

One reason for repeating the experiment with the same sample eight months later was that our results were so different from Ravn and Gelman's. Analysis of the total number of correct responses at the second time of testing are presented here.

Table 5 here

Again significant differences were found between the age groups and Tukey tests revealed that 3 and 8 year olds were significantly more successful than the 5 year olds. As at the first time of testing rule usage analysis showed 3 and 8 year olds to be using the correct rule significantly more often, and the 5 year olds to be using the height rule significantly more often than 3 year olds.

If we turn now to interpret these findings, it seems that the theoretical positions of Ravn and Gelman and Maratsos are neither wholly supported by these data. Ravn and Gelman are correct that children might draw upon a variety of rules when using the term big. But their thesis, that when tested on enough trials to distinguish rule usage, three year olds are haphazard in their responses, is not borne out in the data from this experiment (nor indeed our pilot work). As many three year olds as older children used a rule of one description or another.

The Maratsos claim, that the decrement in children's performance results from the increasing importance of height in the child's judgements, receives partial support from our data. Significantly more five than three year olds used a height rule, but only 25% of children in the former group appear to be hell bent on deriving bigness from the height of a stimulus and many of the so called "decrements" found at five were also apparent nearly three years later in our oldest age group. So, we sought another explanation for the changes in children's performance, by carrying out two further types of analysis: comparisons of individual children over time and examinations of consistencies within children's errors at each age.

Table 6 here

We, firstly, looked at individual children's performances at the two times of testing. A cursory examination of rule usage over time reveals both consistency of rule usage and change in each of the age groups. Thirty-four per cent of the sample as a whole used the same rule on both occasions and further children, classified as No Rule users, responded similarly each time. The eight-year-olds were significantly more likely to be consistent. At the same time, half the children changed their approach to the task at the second time of testing. Analysis of the shifts in rule usage in all three age groups suggested no consistent changes in the direction predicted by the cognitive and semantic theorists. For example, there were no moves by the nearly four year olds from correct rule to height rule usage.

Our second analyses examined more closely the errors which children made at each age, in an attempt to understand why and when they may be swayed from a correct judgement. We were particularly concerned that the rule usage procedure prevented us from understanding the approaches adopted by the 30% of "No Rule" users in the sample. So we felt it appropriate to carry out trial-by-trial analyses of children's responses. An examination of the errors made by the No Rule users revealed that the children at five and eight did not consistently fail at one or two trials, but 8 of the 11 "No Rule" users at 3 years were correct throughout the experiment, apart from the final two extreme dimension trials (where the extreme stimulus was tall and thin). This response pattern was significantly more prevalent among the 3 year

olds, which suggests that there was some method in the approach of many No Rule users at that age. Indeed if we look (see table 7a) at the responses of all the three year olds to three trials, where height-based judgements led to and incorrect response - the equal height, unequal height and extreme dimension pairs - it is clear that their poor performance on the extreme dimension comparison contrasts with their almost flawless responses to other stimulus pairs.

Table 7 here

The 5 and 8 year olds also appear to have been influenced by the types of comparison which they were asked to make. In both groups there was a linear relationship between height discrepancy and the number of children's errors, and analyses of the differences between trials showed that this trend was significant for the five year olds. Such regularity in the children's errors was not present when width discrepancy was salient.

While 5 and 8 year olds appeared to make errors in a wider variety of trials we noticed a pattern which was consistent across pairs of trials at both times of testing. In order to measure stability of rule usage, Ravn and Gelman's method presents the child with more than one pair of stimuli for each type of comparison. We found that in each of these pairs of trials the children made fewer errors on the second, irrespective of whether area differences between pairs increased or decreased. So, for example, two trials assessed the child's judgement of equal height, unequal width comparisons. As this table (7b) shows the five and eight year olds made significantly fewer errors on the second equal height comparison than the first.

Such shifts in judgement suggest that the responses made by the children were in part influenced by procedural cues - a finding reminiscent of much research in other cognitive developmental areas. Some children, particularly the 5 year olds, approached the task in a different way from the Correct Rule users. They spent time examining the stimuli and looking from the pairs to the experimenter and back again, especially when the height discrepancy between the pairs was minimal or nonexistent. Having guessed which one was 'bigger' (or taller) on the first presentation some tended to revert to an area rule when comparing the second pair of cards.

We would like to make two points in conclusion. Firstly, our rule usage analyses at the two time intervals suggests that some children at each age are consistent in their use of the term big and a few use area as the only criterion for judgement. This suggests that we should consider differences within age groups as well as comparisons between them, when examining the acquisition of terms denoting size. We sorely lack individual longitudinal data over the fifth year when shifts towards height rule usage amongst some children appear to take place.

Secondly, our analyses of different trials suggests that children's judgements of size are the product of both their internal working models and the contexts in which they make judgements. The cognitive and semantic explanations for the poorer performance of five year olds, that children come to abstract only one attribute from terms which they previously have used correctly in particular contexts, is partly supported by our data. For example, 40% of the five year olds consistently used one criterion - height or the salient dimension - to assess bigness. However those who made errors in this experiment appeared not simply to be working from inappropriate premises. Such

children responded differently to different types of trial, erring towards height when height discrepancy increased, and shifting towards correct responses on repeated presentations. The poor performance of the five year olds may well reflect an increased awareness of the common use of big to refer to tallness, which co-exists with the more precise area based definition. Many authors have commented upon the ambiguities in adults' use of the word to children - to mean grown up, tall or even fat -, but do not regard such inconsistencies in input as being of central importance in explaining the "decrement" after the age of three. Our results suggest that in experiments like this some five year olds may simply be displaying their knowledge of the plurality of uses to which we put fuzzy trms like big.

TABLE 1: STUDY DETAILS

MEAN AGE	AGE RANGE	SAMPLE	Total
3;3	3;0 - 3;6	12 boys, 17 girls	29
5;7	5;2 - 5;7	20 boys, 20 girls	40
~7:11	7;3 - 8;5	20 boys, 20 girls	40
			109

TABLE 2

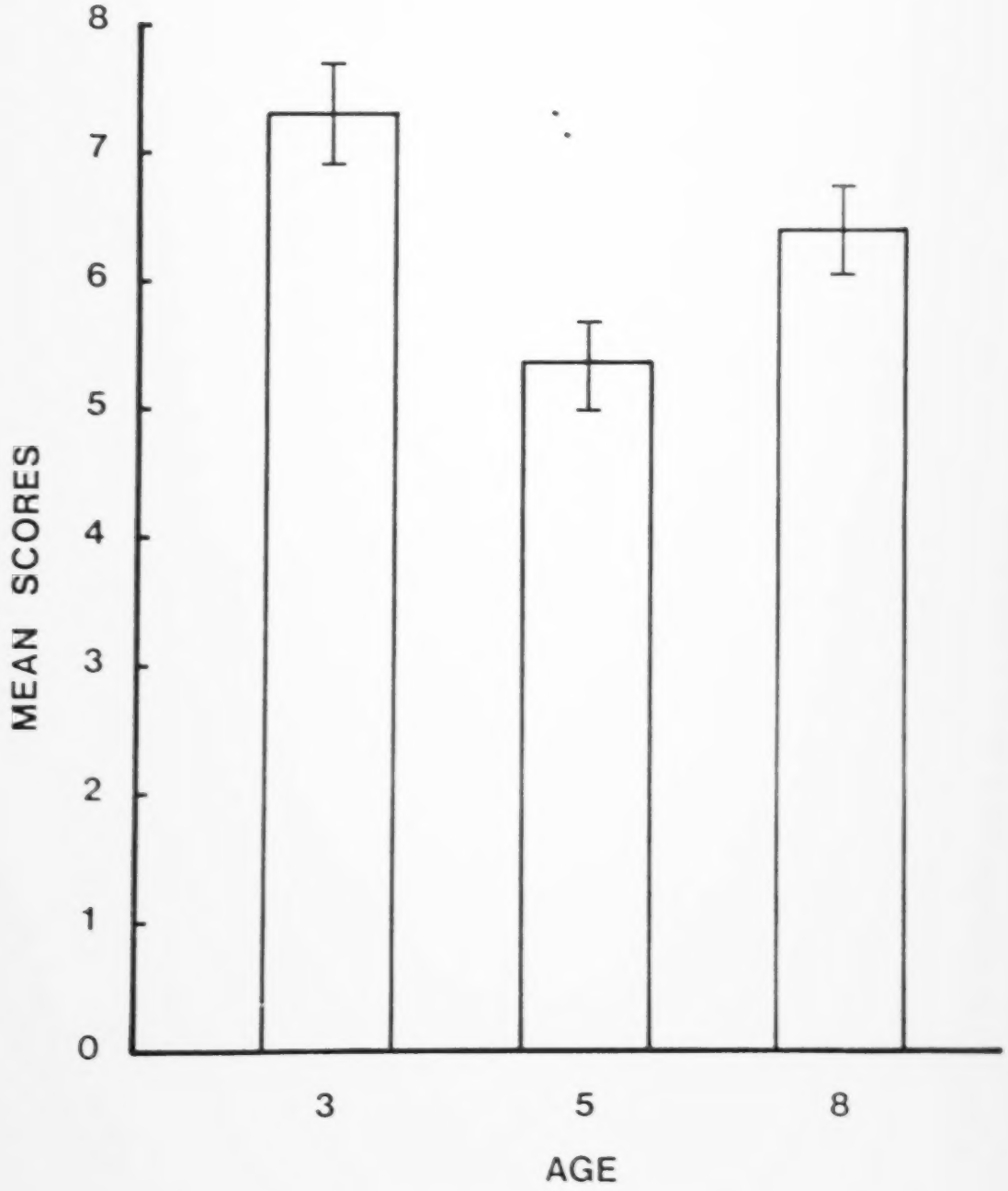
PREDICTED PATTERNS OF RESPONSES ACCORDING TO EACH RULE

	RECTANGLE PAIRS								
	B	C	F	G	H	I	J	K	L
RULES:									
Correct	1	1	1	1	1	1	1	1	1
Height	S	S	0	0	1	1	1	0	0
Width	1	1	1	1	0	0	0	1	1
Salient-dimensional-difference rule.....	1	1	1	1	1	0	1	0	1
Salient-dimension rule.....	1	1	S	1	1	0	0	0	0

KEY: 1 = child gives correct response
0 = child gives the incorrect response
S = child says that they are the same

TABLE 3.

MEAN NUMBER OF CORRECT RESPONSES TO NINE "BIG" QUESTIONS FOR EACH AGE GROUP (STANDARD ERROR BARS ALSO SHOWN)



Comparison between age groups

$F(2, 106) = 6{\cdot}81 \quad p < 0{\cdot}005$

TABLE 4
NUMBER OF CHILDREN USING EACH RULE

	Correct rule	Height rule	S.D.D. rule	S.D. rule	No rule	TOTAL
AGE:						
3 YEARS	12	1	3	2	11	29
5 YEARS	7	10	2	6	15	40
8 YEARS	17	12	0	1	10	40

ANALYSIS:

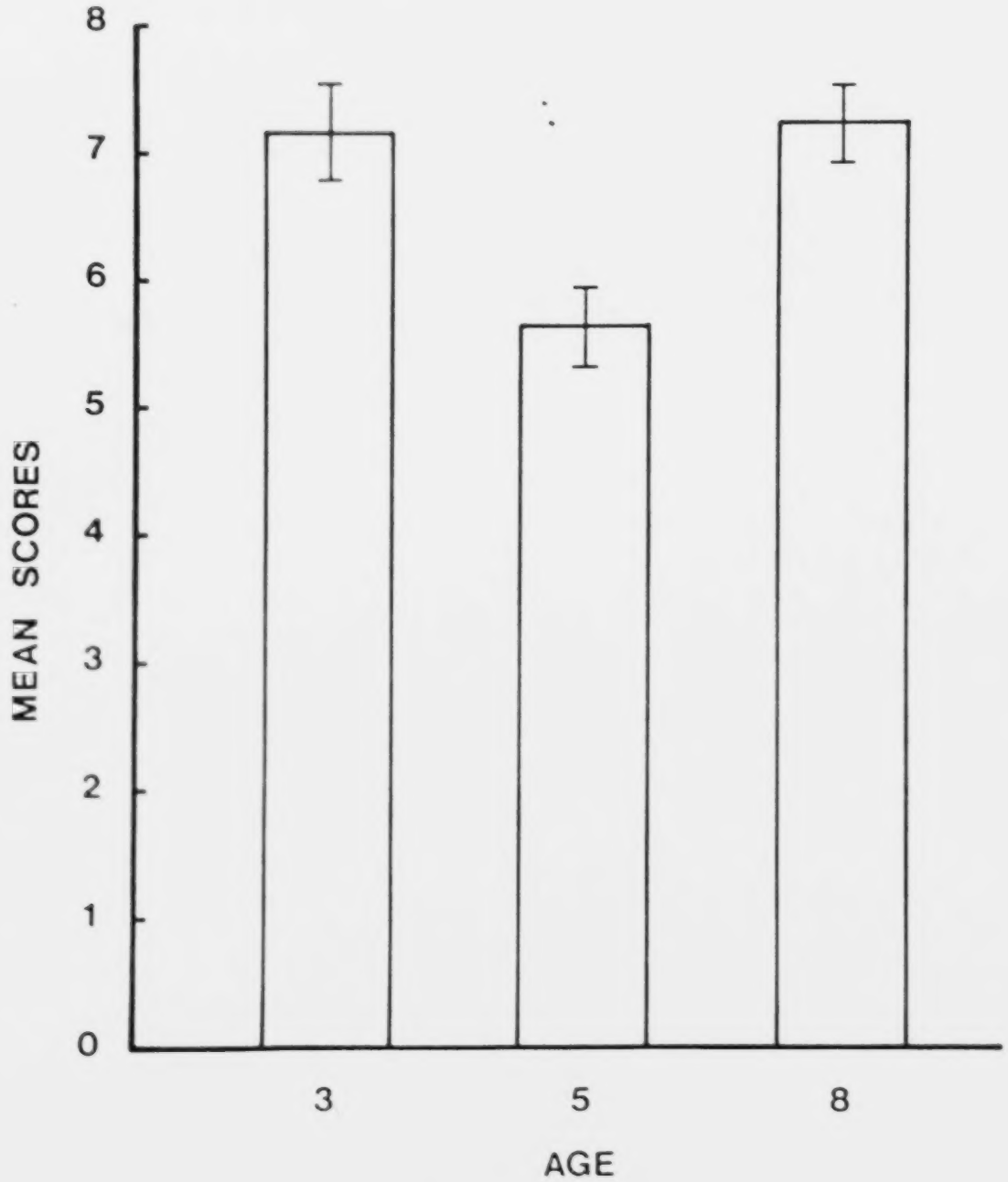
No Rule - 3 = 5 = 8 NS

Correct Rule - 3 > 5: Chi-square = 4.8, df=1, $p<0.05$
8 > 5: Chi-square = 5.9, df=1, $p<0.05$

Height Rule - 5 > 3: Chi-square = 4.3, df=1, $p<0.05$
8 > 3: Chi-square = 6.7, df=1, $p<0.01$

TABLE 5.

MEAN NUMBER OF CORRECT RESPONSES TO NINE "BIG" QUESTIONS FOR EACH AGE GROUP. (AT SECOND TIME OF TESTING)



Comparison between age groups

$F(2, 99) = 7{\cdot}43 \quad p < 0{\cdot}005$

TABLE 6
CONSISTENCY OF RULE USAGE OVER TIME
(all 3 age groups together)
TIME 1

TIME 2	Correct rule	Height rule	S.D.D. rule	S.D. rule	No rule	TOTAL
Correct	22	5	1	2	8	38
Height	4	11	0	2	6	23
S.D.D	1	0	0	0	1	2
S.D.	2	0	1	1	2	6
No Rule	6	5	2	2	16	31
TOTAL	35	21	4	7	33	100

TABLE 7: ANALYSES OF INDIVIDUAL TRIALS

(a) B v F v K

	SUCCESS ON TRIAL: 3 years		5 years		8 years	
	YES	NO	YES	NO	YES	NO
TRIAL:						
B	28	1	24	16	28	12
F	25	4	17	23	22	18
K	11	18	7	33	17	23

McNemar Chi-squares: 3yrs: B v F: 15.06, $p < 0.01$
B v K: 12.07, $p < 0.01$

5yrs: B v F: 4, $p<0.05$
B v K: 15.05, $p<0.01$
F v K: 8.1, $p<0.01$

8yrs: B v K: 8.1, $p<0.01$

(b) B v C

	SUCCESS ON TRIAL: 3 YEARS		5 YEARS		8 YEARS	
	YES	NO	YES	NO	YES	NO
B	28	1	24	16	28	12
C	28	1	32	8	34	6

McNemar Chi-squares: 5 yrs: 4, $p<0.05$
8 yrs: 4.9, $0<0.05$

FIG. 1. RECTANGLE PAIRS USED IN THE EXPERIMENT